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MEASURING DISCRIMINATORY CREDIT RATIONING IN RURAL FINANCIAL MARKETS: A METHODOLOGICAL APPROACH

by

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Abstract

This paper analyzes an appropriate methodology for studying discriminatory credit rationing in rural credit programs with fixed interest rates. The paper demonstrates that in order to analyze credit discrimination one should have a well-defined loan demand and supply model. The criteria by which loan applications are accepted or rejected should be explicitly incorporated into the analysis. The paper also demonstrates that the estimation of the model should consider not only data on loans granted but also on loans rejected. Finally, the empirical analysis implemented in this study shows that this loan demand and supply model is quite adequate for analyzing the discriminatory policies followed for a rural credit program in Portugal after the 1974 Revolution.

INTRODUCTION

Non-price rationing in credit markets, as a substantive issue of theory and policy, is a subject not only of primary importance, but of considerable controversy. During the past three decades many low income countries (hereafter called LICs) created a variety of specialized agricultural lending institutions organized to provide to predetermined group(s) of rural producers, regions, and/or agricultural activities with agricultural loans at subsidized rates of interest. It was believed that by providing targeted credit to some group(s) of rural producers (or regions) they could be induced to use more modern technologies to accelerate agricultural growth. Contrary to these expectations, however, available empirical evidence suggests that most rural credit programs implemented in LICs have highly discriminated against small producers, with credit often diverted to the largest and most influential producers, thus worsening rural income distribution [Gonzalez-Vega, 1984*b*].

The financial market literature has attempted to explain discriminatory credit rationing by considering "legal" and "social constraints, high screening costs, and most convincingly, asymmetry of information in credit markets (for details, see Hodgman [1960], Jaffee and Modigliani [1969], Jaffee and Russell [1976], Azzi and Cox [1976], Baltensperger [1978], Keeton [1979], Stiglitz and Weiss [1981], Devinney [1986], and Bester [1987]).

This literature, however, has not explained how the credit rationing process takes place. Presumably, it is considered that the discriminatory process is carried out by random rejection. However, as empirical evidence indicates, this is clearly unrealistic.

More recent efforts made to explain the discriminatory process in rural financial markets have identified cheap-credit policies and high operational costs per unit of money loaned as some of the most important factors causing the disappointing results observed in rural credit programs.[1] It has been argued that cheap-credit policies tend to create excess demand thereby forcing agricultural lenders to ration credit through non-price mechanisms. Since operational costs and associated risks in servicing large rural producers are lower than those associated with small producers, the agricultural lender is motivated to favor the largest farmers in order to reduce per unit lending costs [Gonzalez-Vega, 1984*a*].

Traditionally, empirical studies have established discrimination against some class(es) of borrowers (or regions, or agricultural activity, etc.) by checking whether the dummy variable for that class of borrowers (or region) is significant in a linear discriminant, probit, or logit function. However, if the dummy variable coefficient for the selected class of borrowers is negative and statistically significant in a discriminant function, this cannot be interpreted as evidence of discrimination since linear discriminant, probit, or logit models are reduced (single equation) form variety. Hence, it is not possible to determine whether the dummy variable for some class of borrowers (or region) is negative because of the demand or the supply function.

This can be better explained through an example. Let's assume that we attempt to determine if a class of borrowers denoted as IND has been discriminated against in a typical credit program by checking the sign and statistical significance of the dummy variable IND

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[1]For an extensive analysis of the impact of cheap-credit policies on rural credit markets cfr. Adams, Graham, and Von Pischke [1984].

in a probit model. Let's assume that the coefficient obtained for this class of borrowers int he probit model is negative and statistically significant. Hence, the probit analysis concludes that the IND borrowers have been discriminated against in the credit market. Now, let's assume that we also attempt to analyze if this class of borrowers (IND) have been discriminated against by estimating the following simultaneous equation model:

$$\begin{aligned} &\textit{LOAN DEMAND: } L^D = \alpha_0 + \alpha_1 IND + \alpha_2 X_1 + \alpha_3 r + \mu_1 \\ &\textit{LOAN SUPPLY: } L^S = \beta_0 + \beta_1 IND + \beta_2 X_2 + \beta_3 r + \mu_2 \end{aligned} \qquad \textbf{(1.1)}$$

where IND is the dummy variable corresponding to the class of borrowers under study; r is the loan rate of interest; X_1 and X_2 are vectors of explanatory variables; αs and βs are parameters; and μ_1 and μ_2 are disturbance errors. Assume that, after solving the model specified above by appropriate methods, α_1 is negative and statistically significant in the demand function, but β_1 is not statistically different from zero i.e., IND borrowers demand less than other classes, but in terms of granted loans they are not different from other groups. In other words, IND borrowers are not experiencing discrimination in the market, contrary to the discriminant analysis report. Consequently, in order to analyze discriminatory credit rationing in rural credit markets one has to have a well defined loan demand and loan supply model.

The main objective of this paper is to discuss appropriate procedures for analyzing discriminatory credit rationing in rural credit markets with non-negotiable (or exogenous) interest rates. The specific objective is to analyze if there was any discriminatory credit rationing in lending activities of a Portuguese rural credit program (the **Fundo de Melhoramento Agricola**) after the 1974 Revolution which changed from a dictatorial to a

more democratic (socialist oriented) regime. The analysis is carried out through a loan demand and loan supply model with explicit consideration of a non-negotiable interest rate (imposed from outside), and the criteria by which credit applications were accepted or rejected.

I. THE MODEL

The model considered in this study draws on that of Nelson [1977] for labor markets, and Maddala and Trost [1982] for loan markets. The model applies to non-negotiated agricultural loans where the rate of interest for each loan transaction is not determined by the intersection of the demand and supply functions but is exogenously imposed from outside. We will assume that the ith loan applicant demand an amount L_i^D at the fixed interest rate, r. The agricultural lender, on the other hand, after evaluating the applicant's available informational set, will decide on the maximum loan amount L_i^S that he/she is willing to offer this customer (Aguilera, 1990). If $L_i^D \leq L_i^S$, the loan transaction will take place. If it is not, the loan request will be rejected. The model may be represented as follows:

$$L_i^D = \beta_1' X_{1i} + \alpha_1 r + \mu_1 \tag{1.2}$$

$$L_i^S = \beta_2' X_{2i} + \alpha_2 r + \mu_2 \tag{1.3}$$

$i = 1,....,n$ (*applicants*),

where L_i^D is the loan request from the ith applicant; L_i^S is the maximum amount that the lender is willing to offer to the ith applicant given the available information on that borrower; r is the fixed interest rate; X_i is a K-element vector of observable explanatory variables; and μ_1 and μ_2 are random disturbances that follow a bivariate binormal distribution with zero mean vector and unknown variances and covariances, σ_1, σ_2, and σ_{12}. Both disturbances are assumed to be independent of X_i.

The criteria by which the lender decides to grant or reject a loan may be represented as follows:

$$L_i = \begin{cases} L_i^D, & \text{if } L_i^D \leq L_i^S \\ 0, & \text{if } L_i^d > L_i^S \end{cases} \qquad \textbf{(1.4)}$$

where L_i is the observed loan amount. The criteria function (1.4) defines two sets of observations: n_0, the subset of the rejected loans; and the subset n_1, the subset of granted loans. Since the systems of equations (1.2)-(1.4) is a simultaneous equations model with censoring,[2] an identification problem arises. Given the fact that the model is similar to that of Nelson [1977], the necessary condition for identification of the system requires one restriction among the set β_2, σ_2, σ_{12}. For example, if some element of β_2 is restricted to zero, the necessary condition is satisfied, even in the case that the corresponding element in β_1 is non-zero. Likewise, restricting σ_{12} to zero is sufficient for identification (for details see Nelson, 1977).

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[2]Notice that L_i^S is never observed.

The more appropriate estimation procedure of the model is the Maximum Likelihood technique. Following Nelson [1977], the model may be estimated as follows: Since, the data on the amount a loan applicant requests is usually available, and assuming that the necessary conditions for identification are satisfied, then the demand function may be estimated by ordinary least squares (OLS). The supply function (1.3), in turn, may be estimated with a simple probit model with a known threshold. From criteria function (1.4) we know that whenever $L^S \geq L^D$ the loan is granted. Hence, by replacing Equation (1.3) for L_i^S we get $\beta_2' X_2 + \alpha_2 r + \mu_2 \geq L^D$. If $L^S < L^D$, the loan is denied. Thus the likelihood function for the model may be written as

$$L(\beta_2, \sigma_2, X) = \prod^{n_0} \phi\left(\frac{\beta_2' X - L^D}{\sigma_2}\right) \prod^{n_1} \left[1 - \phi\left(\frac{\beta_2' X - L^D}{\sigma_2}\right)\right] \qquad (1.5)$$

where the first product is over all observations for denied loans, and the second is for all observations for granted loans; and Φ is the unit normal distribution function.

The likelihood function 1.5 suggests that if the loan amount demanded is not considered in the estimation of the discriminant function, a specification error will arise. It also suggests that, unlike the case of the normal probit model, since the amount of loan demanded (L^D) is observed, we will be able to estimate σ_2; the reciprocal of the coefficient for L^D.

II. THE DATA

The data for this study are described in detail in Mansinho [1990]. The data for this study consist of 5,980 loan applications during 1974-1979 from the *Fundo de Melhoramento*

Agricola (hereafter called FMA) statistics, a classic supply leading agricultural credit program managed through the Ministry of Agriculture in Portugal from the late 1940s to 1979. The period 1974-1979 was chosen to investigate the impact on the loan portfolio of the economic and political changes that occurred in Portugal after the 1974 Revolution. The data terminates in 1979 the last year that the FMA operated. Table 1 presents the definition of the variable used in this study.

Table 1

DEFINITION OF VARIABLES USED IN THIS STUDY

VARIABLE	DESCRIPTION
INT	Interest rate on loan
LOAND	Amount in Contos of loan demanded (basis 1976).
LOANS	Dummy = 1 if loan is granted
TYPE OF BORROWERS	
AGRE	Dummy = 1 if member of the agrarian reform sector
COOP	Dummy = 1 if cooperative
IND	Dummy = 1 if individual
COLLATERAL	
MORTG	Dummy = 1 if mortgage collateral
TYPE OF INVESTMENT	
SOIL	Dummy = 1 if soil preparation or irrigation
FRUIT	Dummy = 1 if fruits
LIVEST	Dummy = 1 if livestock
CUL	Dummy = 1 if horticulture
INDUS	Dummy = 1 if agroindustry food crops
REGION	
NORTH	Dummy = 1 if north
SOUTH	Dummy = 1 if south
CENTER	Dummy = 1 if center
LISB	Dummy = 1 if Lisbon
TIME DELAY IN LOAN DISBURSEMENT	
DELAUT	Number of months to disburse a loan.

III. THE RESULTS

The estimated demand and supply model is the following:

$$\begin{aligned} \textit{Demand: } LOAND = {} & \beta_0 + \beta_1 INT + \beta_2 AGRE + \beta_3 COOP + \beta_4 MORT + \\ & \beta_5 SOIL + \beta_6 FRUIT + \beta_7 LIVEST + \beta_8 INDUS + \\ & \beta_9 NORTH \beta_{10} + SOUTH + \beta_{11} CEN + \beta_{12} DELAUT + \mu_1 \end{aligned} \tag{1.6}$$

$$\begin{aligned} \textit{Supply: } LOANS = {} & \alpha_0 + \alpha_1 INT + \alpha_2 LOAND + \alpha_3 AGRE + \alpha_4 COOP \\ & + \alpha_5 MORT + \alpha_6 SOIL + \alpha_7 FRUIT + \alpha_8 LIVEST + \alpha_9 INDUS \\ & + \alpha_{10} NORTH + \alpha_{11} SOUTH + \alpha_{12} CEN + \mu_2 \end{aligned} \tag{1.7}$$

where LOANS is the dummy variable defined as follows

$$LOANS \begin{cases} = 1, \textit{ if loan is granted} \\ = 0, \textit{ otherwise} \end{cases}$$

The variables are defined in Table 1. The results of the demand and supply model with exogenous interest rates are set forth in Table 2. The supply equation was estimated by probit model. The demand equation, in turn, was estimated by ordinary least squares.

The Results

The interest rate coefficient (INT) shows, as expected, a positive and highly significant sign (t-ratio 18.5, significant at 1 percent level) in the supply function, and a negative but insignificant sign in the demand function. The insignificant sign for INT in the demand function is not surprising if we consider the subsidized and non-negotiable nature of the fixed interest rate in this credit program: The borrower 'must' accept the offered interest rate.

The negative and significant sign (t-ratio -2.3 significant at 5 percent level) for LOANS (the requested loan amount) indicates that applicants demanding large loan sizes were discriminated against in the program. This result makes sense if we consider that the socialist government after the 1974 Revolution was more inclined to favor small rural producers.

The sign obtained for MORTG in both the supply and demand function provide us with an interesting result. Contrary to our expectations, the applicant's ability to provide mortgage as collateral, instead of crop lien pledges, is negatively correlated with the probability of getting a loan. This result suggests that mortgage collateral was not considered by the lender as a risk-reducing mechanism. It appears to be that the ability of providing mortgage as collateral was considered by the lender as a sign of high income than a risk-reducing mechanism. The positive correlation between income and the ability of providing mortgage collateral is reflected in the positive sign obtained for MORTG in the demand function. Thus, if MORTG is a proxy for the applicants' income, we may conclude that large-income loan applicants were discriminated against in this credit program. This result is perfectly consistent with the socialist orientation of the post-revolutionary regime in Portugal.

Another interesting result is provided by the negative and significant sign obtained for DELAUT in the demand function. This indicates that delays in loan disbursement created a negative incentive on the demand side. Delaying the loan disbursement can be interpreted as increasing borrowers' transaction costs. Thus, it is quite reasonable a negative sign appears for DELAUT in the demand function.

Discriminatory Credit Rationing by Type of Borrower.

The negative and significant sign obtained for COOP in the supply function, and its positive and significant sign in the demand function suggests that during the post-revolution period agricultural farmers associated with private farmer cooperatives were highly discriminated against by the FMA's management. Agrarian reform beneficiaries, on the other hand, were highly favored during this same period of time. These results make sense if we consider the nature of the new regime established after the 1974 Revolution in Portugal.

Discriminatory Credit Rationing by Type of Activity.

The signs and statistical significance obtained for agricultural activity variables allow us to conclude that the FMA tended to favor soil preparation and irrigation, livestock, and industrial food crop investment. In fact, the sign and significance of the coefficients for SOIL, LIVEST, and INDUS are all positive and highly significant, while horticulture, and fruit activities tended to be discriminated against.

Discriminatory Credit Rationing by Region.

The analysis of the sign and significance permit us to conclude that the FMA credit program tended to favor applicants from the north, while applicants from the south (a region with the larger concentration of larger farms) tended to be discriminated against. Effectively, the sign obtained for NORTH in the supply function is positive and moderately significant (t-ratio 1.7, significant at 10 percent level). The sign obtained for SOUTH in the supply function, in turn, is negative and highly significant (t-ratio -1.9, significant at 5 percent level).

Table 2

ESTIMATES OF LOAN SUPPLY AND DEMAND MODEL WITH FIXED INTEREST RATE

Pooled time series cross-section data: *Fundo de Melhoramento Agricola* (FMA) Portugal 1974-1979.

VARIABLE	SUPPLY (PROBIT) (LOANS = 1 if loan is granted	DEMAND (OLS)
INTERCEPT	-1.56 (-2.2)*	-0.01 (-0.1)
INT	0.002(18.5)**	-0.001(-0.6)
LOANS	-0.02 (-2.3)*	
MORTG	-0.16 (-3.9)**	0.22 (5.5)**
DELAUT		-0.01 (-2.3)*
TYPE OF BORROWERS		
AGRE	0.12 (2.4)*	0.14 (3.4)**
COOP	-0.40 (-5.6)**	0.78 (3.9)**
TYPE OF INVESTMENT		
SOIL	0.78 (9.0)**	0.36 (3.4)**
FRUIT	0.09 (0.8)	0.59 (3.6)**
LIVEST	0.69 (7.3)**	0.34 (2.3)*
INDUS	1.09 (6.9)**	5.20 (7.3)**
REGION		
NORTH	0.10 (1.7)	-0.03 (-0.3)
SOUTH	-0.06 (-1.9)*	-0.13 (-2.0)*
CENTER	0.02 (0.3)	-0.29 (-3.6)**
		RSQ = .24
		F-STAT. = 152.9

Total number of observations = 5,980
Number of Loan Applicants Rejected = 2,319
Number of Loan Applicants Accepted = 3,661
RSQ = R-square between observed and predicted
F-STAT = F-Statistic
Figures in parentheses are asymptotic t-ratios for the supply function, and exact t-ratios for the demand function.
** significant at 1 percent level.
* significant at 5 percent level.

IV. CONCLUSIONS

The present paper argued that in order to analyze discriminatory credit rationing in rural credit programs, one should have a well-defined demand and supply model, which should be estimated by using not only data on loans granted, but also on loans denied. Moreover, the estimation of the supply function should be estimated considering the loan amount demanded as an additional explanatory variable, otherwise there would be a specification error in the model.

The paper illustrates the loan demand and loan supply model with non-negotiable loan contracts using loan information provided by a Portuguese agricultural development institution, the *Fundo de Melhoramento Agricola* during the period 1974-1979. The 1974 Revolution changed a dictatorial regime to a more democratic (socialist oriented) regime with a completely different social and economic perspective than the old regime.

The results show a clear discrimination against large farmers, farmers associated with private cooperatives, horticulture and fruits activities, and applicants from southern Portugal. These results reflect the socialist character of the new regime established in Portugal during the period under study.

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